# Distinguishing Burials in Thebes, Greece: Using MNI and MLNI as a Differentiation Technique

by

Ava Giachino

A thesis

presented to the University Of Waterloo

in fulfilment of the

thesis requirement for the degree of

Master of Arts

in

Anthropology

Waterloo, Ontario, Canada, 2016

## Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

The objective of this thesis was to determine an additional method to help distinguish between types of burials in Thebes, Greece and generally in archaeological remains. Using two quantification methods, MNI and MLNI, it was hypothesized that differences and similarities between the estimation values could help categorize a burial as a mass grave or a multi-use burial. In order to test this hypothesis, five graves were analyzed in Thebes, Greece. Two graves had estimation values that categorized them as mass graves, two graves had estimations values that distinguished them as multi-use burials, and one grave had estimation values that presented a complicated categorization. These two quantification techniques were applicable in differentiating between two burial types at the archaeological site in Thebes.

Acknowledgements

First and foremost, I would like to thank my supervisor, Dr. Maria Liston for believing in me and supporting me with my research. You gave me the confidence that I needed to complete this thesis and the encouragement that I needed when doubt started creeping in. Without your guidance and faith you placed in my abilities I would not have been successful. Thank you.

Second, I would like to thank Dr. Stephanie Larson and Dr. Kevin Daly from Bucknell University for the access to the archaeological remains in Thebes. I am forever grateful for your support and generosity, without it this research would not have been possible. You have inspired me to think beyond osteology and made research very enjoyable.

Lastly, I would like to express my appreciation to my committee members, Dr. Mary Jackes and Dr. Bonnie Glencross. I cannot thank you enough for the time and energy that you committed to my thesis research. The comments and questions you offered on the document and presentation provided insight and angles that allowed me to create the best possible version of my thesis.

Dedication

To my family – Mom, Dad, and Emma. Always the most supportive and encouraging people in my life, I would not be where I am today without you. Thank you Mom and Dad for always trying to understand what I am studying so you can offer the best support. Emma, you always keep me sane and know exactly what to say in stressful situations.

To my aunt and uncle. Thank you for the help and support you have provided throughout this process.

Table of Contents

List of Figures

List of Tables

# CHAPTER 1

## Proposed Venue of Publication

I examined human remains from selected Byzantine burials for a large multi-use and multi-period site in Thebes. By examining these burials I am looking for insight into funerary practices of the past inhabitants of Thebes. The result of this study contributes to the study of cultural practices and beliefs that were held by the people in the transition from the Late Roman to Early Byzantine periods. I examined Minimum Number of Individuals (MNI) and Most Likely Number of Individuals (MLNI) and explored how the accuracy of these estimations can help with understanding burial context.

Without the initial development of these techniques from faunal remains by zooarchaeologists, there would be no foundation for the use of these two techniques for human populations. The use of these methods in my research may be appealing and of interest to zooarchaeologists as well as bioarchaeologists.

The peer-reviewed scholarly journal chosen as a proposed venue for this research is the International Journal of Osteoarchaeology. This journal is read by a variety of specialists who research human and animal remains in an archaeological context from numerous areas around the world. The International Journal of Osteoarchaeology describes their main focus as gathering information about culture and behaviour of past populations through the analysis of human and faunal remains. Specifically, the journal designates that articles focusing on methodology, paleopathology, and biomolecular analysis are important areas of study for analyzing and understanding past human populations. I am focused on human remains from an archaeological site in Greece. I am using methods that are theoretically informed and use the results I have gathered to help provide knowledge about funerary practices and burial context in Greece. Thus, I am contributing to our knowledge of the behaviour and belief systems in a past population group. Additionally, I analyze methods used in studying my selected population and the results of this research have the potential to be applied in a more widespread archaeological and forensic contexts.

Public Issues

The significance of this research can be connected to current forensic cases containing commingled remains in mass graves as well as funerary practices within Greek culture. When mass graves are discovered in connection with crimes and violence, it is important to be able to identify how many individuals are contained within the grave. Once excavation has occurred, knowing the numbers of individuals in the grave is an initial step in helping to identify these individuals (Garrido Varas and Intriago Leiva, 2012; Jessee and Skinner, 2005). The results obtained through my thesis research have the potential to be adapted for contemporary work distinguishing between different types of forensic mass graves. It can also contribute to the investigation and prosecution process of war crimes, genocides, and serial murders. Differentiating between primary inhumation sites and secondary inhumation sites can be challenging when exposed to mass amounts of commingled human remains (Jessee and Skinner, 2005).

Understanding what type of burial forensic experts are excavating is the first phase of helping with individual identification. Knowing whether a grave is a primary burial or a secondary burial can potentially help experts understand the different skeletal elements they are likely to find (Jessee and Skinner, 2005; Roksandic, 2002; Wagner, 2014). Primary and secondary grave identification, and thus identifying numbers of individuals in mass graves, can lead to segregating individuals in commingled assemblages and positively identifying individuals (Wagner, 2014). Once the number of individuals has been determined, building a biological profile and analyzing trauma can help with identification of human remains (Garrido Varas and Intriago Leiva, 2012). Mass graves that are the result of violence can often leave families in the dark waiting to hear about their loved ones (Garrido Varas and Intriago Leiva, 2012; Wagner, 2014). Therefore, the resolution of human rights violations and mass graves can begin with knowing what type of burial has been discovered and how many individuals are in these mass graves (Garrido Varas and Intriago Leiva, 2012).

Identifying numbers of individuals in human skeletal assemblages and depositional context is not unique to forensic cases. It is also a prominent issue with archaeological contexts. Commingling remains as a consequence of secondary burial practices is very common in Greece and still practiced in Greece today (Danforth, 1982; Fox and Marklein, 2014). Archaeological research into collective burials and commingled remains is beneficial for Greek culture because the findings can inform the Greek people of the historical significance of the funerary traditions that are still practiced today (Danforth, 1982; Fox and Marklein, 2014). This research offers a connection between the archaeological past and the present.

There is also the importance of connecting the living with dead. This means explaining what processes the living go through to bury the deceased (Baustian et al., 2014). In Greece, the practice of burial, deliberate exhumation, and reburial or storage of bones are all visible evidence to the living that the soul of their loved one has passed on to paradise (Danforth, 1982). This transition can help the living understand the death of a family member or friend as they can experience various steps that take the deceased from living to a final place of rest (Weiss-Krejci, 2011).

Finally, archaeological research into burial practices in Greece can provide information to educate people who do not practice such burial traditions. A recent BBC News article published on November 26, 2015, explained how many cemeteries in Greece are facing space constraints and families typically only rent a burial plot for a few years before the deceased is exhumed and transported to an ossuary (Hadjimatheou, 2015). This article focuses on the issue of overcrowded cemeteries and financial constraints and how this impacts the dignity of the dead in Greece (Hadjimatheou, 2015). This currently shows how hundreds and thousands years of burial practices are currently being affected by the present problems that are affecting Greece. Comments posted to an online version of this article expressed disgust and disgrace at the exhumation of the dead. My research can help expose how ritualized exhumation and ossuaries have been a part of Greek culture for hundreds of years and can educate people who may not understand these funerary practices.

CHAPTER 2

## Introduction

Located northwest of the city of Athens, Thebes is an important town that has been continuously inhabited over the last 5000 years (Symeonoglou, 1985). Situated in the province of Boeotia in central Greece, Thebes is primarily an agricultural market town today. However, this was not always the case as Thebes was not an isolated city and was a significant place for kings, poets, Greek mythology, production, trading, and warfare (Symeonoglou, 1985). Located on the outskirts of this city is Ismenion Hill, an archaeological site yielding material that ranges from the Bronze Age to the Late Byzantine period (Daly et al., 2013). The first development on this site in ancient Thebes was the Sanctuary of Apollo Ismenion. Excavations began in the 1910s and uncovered evidence that suggested that the Temple of Apollo Ismenion was constructed in three phases and believed to be in use from the 8$^{th}$ century BCE to the 4$^{th}$ century BCE (Symeonoglou, 1985). Presently, only the foundation of the temple remains as evidence of the sanctuary.

The excavations that began at the beginning of the 20$^{th}$ century as well as current excavations at Ismenion Hill have generated vast amounts archaeological material. Evidence of Mycenaean, Classical, and Byzantine materials including fine and coarse pottery, coins, architecture, and burials have been recovered from Ismenion Hill in Thebes (Daly et al., 2013; Symenonoglou, 1985). Seriation of the numerous vessels and coins that have been recovered is important for the relative dating of the site and its various activities (Symenonoglou, 1985). Examples of the types of burials on the site range from pit graves and tile burials to graves with multiple interments and evidence of skeletal removal to ossuaries (Daly et al., 2013; Symenonoglou, 1985). The burials at Ismenion Hill are special in that they allow archaeologists to see variations in funerary practices that occurred from the early Byzantine to the late Byzantine period (Daly et al., 2013).

Burials excavated from Ismenion Hill vary greatly, even within the same cemetery. Since this is the largest cemetery in Thebes from the time period, approximately 7$^{th}$ to 9$^{th}$ century CE, it provides the best evidence for funerary practices that occurred in Byzantine Thebes (Symenonoglou, 1985). The various burial styles include pit graves, tile-covered graves, recycling of certain burials, and ossuaries (Symenonoglou, 1985). The burial environment consists of sandy soil and soft bedrock. Materials found in the graves included unglazed ceramic burial jugs and copper coins (Liston, personal communication, 2015).

Many of these burial practices may be responsible for the amount of commingling that has become an established sight of many archaeological locations in Greece (Danforth, 1982; Fox and Marklein, 2014). It has been well documented as a funerary practice in rural Greece that once individuals have been interred they are then exhumed after an allotted period of time and selected remains are brought to a secondary location (Danforth, 1982). In archaeological contexts, these initial or primary burials may have included multiple individuals that became commingled over time as skeletal elements were ritually interred or exhumed (Fox and Marklein, 2014). As the living have a direct impact on the burial of the deceased, humans can play a large role in the modification, alteration, or commingling of human remains (Atici, 2014; Baustian et al., 2014; Danforth, 1982; Sorg and Haglund, 2002; Ubelaker, 2002; Ubelaker and Rife, 2008). Understanding these commingled human remains in Thebes will be able provide information on the numbers of individuals present and how that can contribute understanding about the funerary practices of the past populations and how human interference may have impacted these burials. (Konigsberg and Adams, 2014).

There are two primary techniques of estimation used by bioarchaeologists when working with commingled human remains, Minimum Number of Individuals (MNI) and Most Likely Number of Individuals (MLNI). MNI estimates the minimum number of individuals represented by a recovered skeletal assemblage by counting the most common element (Adams and Konigsberg, 2004). This means that only the bones that have been recovered from an archaeological site can be used to establish a minimum estimate. MLNI aims to "estimate the *original* number of individuals in an osteological assemblage" (Adams and Konigsberg, 2008:241). This means that MLNI is used to determine the number of individuals that were initially deposited in a grave. This is where the difference between these two estimation techniques becomes apparent. MNI can only work with the bones that have been found, whereas MLNI accounts for instances where bones are missing from a grave or assemblage. If bones have been removed from a grave or have disappeared because of taphonomic processes, accurate estimations of number of individuals can still be calculated (Adams and Konigsberg, 2004, 2008).

In order to calculate MNI, skeletal elements must be sorted by type of bone and then each type of bone is sorted into sides. Once this sorting is complete, the most repeated element is taken as the minimum estimate (Adams and Konigsberg, 2004, 2008). For example, if 25 right humeri and 20 left humeri were found in a skeletal assemblage, the right humeri are the most abundant and the MNI would be 25. MLNI uses a formula that compares lefts, rights, and pairs of the same bone in order to estimate the likelihood of maximum number of individuals (Adams and Konigsberg, 2008). This formula is represented as MLNI = $[(L + 1)(R + 1)/(P + 1)] – 1$ (Adams and Konigsberg, 2004). Using the example of the humeri from above, if there were 25 rights, 20 lefts, and 15 pairs then substituting these numbers into the formula would give a MLNI point estimate of 33 individuals. The higher number from the MLNI ideally reflects a more accurate estimation of the original population in the grave.

While MLNI may provide a more accurate estimation of number of individuals, both techniques are still valuable in quantifying remains. MNI can be used when analyzing fragmentary remains, as long as the same osteological landmarks are present on all the bones in the sample (Adams and Konigsberg, 2008). The most important part of MLNI is that bones must be sorted into pairs; however, there are instances in archaeological samples where preservation is extremely poor and pair-matching cannot be accomplished. In cases where there is poor preservation, MLNI will not provide a very accurate estimation of number of individuals and so MNI should be utilized as the estimation technique (Adams and Konigsberg, 2008; Herrmann, Devlin, and Stanton, 2014; Konigsberg and Adams, 2014). Nevertheless, when preservation is acceptable MLNI should be used as it can provide a much more accurate estimation of numbers of individuals (Adams and Konigsberg, 2004; 2008; Konigsberg and Adams, 2014).

Understanding how many individuals have been recovered from a grave can help bioarchaeologists interpret what type of burial is present. In the case of the commingled remains in Greece, the possibilities are generally primary or secondary depositional sites (Fox and Marklein, 2014). Primary sites would consist of burials or graves where the inhumations had originally occurred (Roksandic, 2002). Secondary burial locations, especially in Greece, are very likely ossuaries, which involve the collection of individuals or skeletal elements that had previously been buried in different locations (Danforth, 1982; Glencross, 2014). Human remains found in primary or secondary burial contexts can both be commingled (Roksandic, 2002). In Thebes specifically, primary inhumations can often contain the commingled elements that are left behind, such as bones from the hands and feet, when larger bones are extracted for secondary burials (Fox and Marklein, 2014). The secondary deposit in an ossuary can also result in an assemblage becoming commingled (Kendall and Willey, 2014).

It can be difficult to differentiate between types of burials, especially ones that contain commingled remains. Of the selected graves analyzed from Ismenion Hill, all of them contained the commingled remains of multiple individuals. There are two types of funerary practices I believe are represented by the five selected graves that were chosen for analysis. The first type is representative of a primary deposition site where selected elements were eventually transported to an ossuary. This burial example likely held numerous individuals over an extended period of time or was re-used for multiple interments (Baustian et al., 2014; Fox and Marklein, 2014; Roksandic, 2002; Weiss-Krejci, 2011). The other style is a burial where individuals were interred at or relatively close to the same time, in what could be categorized as a single event (Adams and Konigsberg, 2004, 2008; Weiss-Krejci, 2011). The latter burial type can be called a mass grave; however, mass graves can have many conflicting definitions due to the relationship with war crimes and genocide (Jessee and Skinner 2005). Often these definitions linked to genocide and human rights violations exclude mass graves from archaeological sites that are the result of epidemic diseases or other traumatic events (Roksandic 2002). For the purpose of this research, I am using the term mass grave to describe a burial where three or more individuals have been buried at or close to the same time.

Graves that contain commingled remains are generally extremely variable and there is not one straightforward methodology for assessing these types of burials (Atici, 2014; Glencross, 2014; Osterholtz et al., 2014; Ubelaker, 2002). The objective of this research is to assess the quantification methods of MNI and MLNI as they pertain to the commingled remains in the selected burials from Ismenion Hill in Thebes. The task is to see if the two types of burials previously outlined can be distinguished by the estimates calculated through MNI and MLNI. If burials have been extremely disturbed and commingled through ritual inhumation and exhumation, it is expected that the results will show low paired numbers and a higher estimated MLNI when compared to MNI. The burials that have minimal disturbance and some commingling will show high paired numbers and MLNI and MNI estimations that are similar. The site directors had specific inquiries and hypotheses about the graves selected for study. This research specifically addresses their questions through the osteological analysis.

## Methods

Over the course of four weeks, I analyzed five burials from the site at Ismenion Hill in Thebes, Greece. Four of the burials were excavated from the top of the hill where the site is located. The fifth burial was found located down the hill from the actual site in a location that is presently a gravel parking lot at the town bus station. Each of these graves had been previously excavated by teams from Bucknell University in earlier dig seasons. These graves were spread out over the site, however, two of the graves were found in very close proximity to one another.

These graves were chosen because they were of particular interest to the excavation directors and contained large numbers of well-preserved but fragmentary skeletons. Analysis was completed for each of the five graves individually. The skeletal material from each grave was segregated by the contexts in which they were recovered and recorded by the excavating archaeologists and volunteers. Keeping the skeletal material in the recorded contexts helped to understand how the bones were recovered but it was quickly found that commingling had occurred prior to excavation. In some cases there were pieces of bone with old breaks that were able to be connected from different contexts. Bones from each grave were sorted by skeletal elements because the graves were all disturbed, with no anatomically arranged skeletons; each grave had to be treated as an assemblage. After the bones were sorted and grouped, I focused on creating complete inventories. It is important for both MNI and MLNI estimations that the same bone is not counted more than once which is why reconstruction of bones and meticulous inventorying needed to be completed first. The inventory charts showing the counts of recovered elements can be found in the Appendix.

After all the bones were sorted into groups by element, they were also sorted into lefts and rights. Siding the skeletal elements is required for MNI estimations to be accurate but also for pair-matching to be successful. The bones were pair-matched using protocols suggested by Adams and Konigsberg (2004). Morphological indicators such as size and shape, including features such as ridges and foramina, robustness, muscle attachments, general symmetry, and to a lesser extent shape of facets, areas of articulation, and biological age, were used to match pairs together (Adams and Konigsberg, 2004, 2008; Adams and Byrd, 2006; Konigsberg and Adams, 2014; L’Abbé, 2005; Ubelaker, 2002). To a degree, individual variation between elements was important for pairing bones together; however, individual variation was mostly utilized as an exclusionary measure to prevent against false matches. Once I had made the matches, they were confirmed by my supervisor in order to reduce the chance of intraobserver error.

Within each grave the adult remains and the juvenile remains were examined separately. I will discuss the methods for the adult remains first and then move onto the juvenile remains. When analyzing the remains I sought out skeletal elements that would be beneficial for both MNI and MLNI estimation. I needed remains that were complete enough to be able to be paired together but I also wanted to use the same skeletal elements for MNI estimations as well as pair-matching in order to create a measurement standard. In some instances this was unrealistic because the most numerous elements that provided MNI estimations were not able to be successfully paired for MLNI estimations. However, in most cases the bones that were able to be successfully paired were also the most numerous and able to provide an MNI estimation.

The bones that were chosen for the quantification methods were based on preservation, abundance, and the ability to be pair-matched, specifically for the adult remains. There were instances with the juvenile remains that this may not have been possible; therefore, most juvenile estimations were based on preservation levels and the abundance of certain bones. This methodology was applied to each of the five burials that were examined. The categorization used to discuss the graves is based on the system that the excavation directors have implemented and each of the graves discussed in this paper are identified as graves 5, 19, 20, 21, and Parking Lot grave 1.

## Grave Sample

The five burials were chosen specifically for this research because of the complexity they presented post-excavation. Graves 19 and 20 seem to be mass inhumations with evidence of deposition that occurred all at once with little post-depositional disturbances. The grave architecture is also different from other burials on the site. One end of the grave was open and the rest of the grave was undercut beneath the bedrock (Liston, personal communication, 2015). In the initial assessment, graves 5 and 21 appeared to represent the typical burial patterns on the site using the secondary exhumation practices that continue to this day (Danforth, 1982). However, instead of complete exhumations it appears that the crania, the upper half of the body and the femora were the elements removed with some variation in the patterns. The final grave, Parking Lot grave 1, was selected as it was a burial isolated from the rest of the site. It contained multiple individuals but there was less evidence of exhumation once individuals were interred. Parking Lot grave 1 is unique due to its isolation from the rest of the site and it is also unique due to the construction of a wall being built through the middle of the grave after deposition but prior to excavation. An ossuary exists in an extension of this cemetery that is still in use, however, it was not part of the excavation area and could not be examined (Liston, personal communication, 2015).

MNI and MLNI

The bones that were found in grave 20 were extremely well-preserved in terms of completeness of the skeletons and the preservation of the individual bones. The six major long bones from this grave were especially well-preserved and as a result can provide both MNI and MLNI estimations. The grave 19 remains had a similar constitution to that of grave 20. Most of the long bones are complete enough to provide MNI and MLNI estimations. In addition, the calcaneus and the talus can also be utilized for the MNI and MLNI estimations in grave 19.

A large majority of the remains recovered from grave 21 were highly fragmented and complete skeletons were absent. In order to estimate the MNI and MLNI for this grave, two tarsals were observed, the calcaneus and the talus. These bones were the most numerous and the only skeletal elements in the grave that could be used for MNI as well as for MLNI. The bones that were excavated from grave 5 were in fairly good condition; however, there were no cranial elements or bones of the upper body. The most numerous elements to for calculating MNI as well as MLNI in grave 5 were the calcaneus, talus, and fibula.

The final grave, Parking Lot grave 1 was more problematic for sorting and inventorying than the other four graves. During excavation for this grave, it was found to have a wall built in the middle of the grave. It is unclear when this wall was constructed in the grave, but there is evidence of post-depositional disturbances and destruction of the remains recovered from the grave. It was necessary to keep the remains organized in the same method that the previous excavators recorded in the grave; therefore, these bones were sorted and evaluated as North side and South side, as the wall separated the grave in this manner. The bones that were most suitable, in terms of abundance and completeness, to be used from this grave for MNI were the talus, fibula, and tibia. This grave was an instance where the bones that could be used to estimate MNI and MLNI were different. The best options for determining MLNI were the talus and the tibia. The constitution of this grave and the problems it presented will be discussed further in another section.

The methodology for analyzing the juvenile remains from each of the graves was different from what was done for the adult remains. The juvenile remains in some cases were not well preserved and were extremely fragmented. As juvenile remains are often not successfully recovered or do not preserve well (Kendell and Willey, 2014; Lewis, 2009; Scheuer and Black 2000), the quantification methods for juveniles in these graves had to be adapted. Due to the lack of paired juvenile bones in this grave, the estimation of the number of juvenile individuals is only recorded through MNI. However, estimating MNI for the juvenile individuals was not a simple process and required examining both the numerous elements as well as estimated ages for certain remains (Ubelaker, 2002).

The juvenile remains that were surveyed varied greatly from grave to grave and in some cases, skeletal elements were used to estimate MNI that were not necessarily available for adults. The petrous portion of the temporal bone was the most numerous element for graves 20, 21, and Parking Lot grave 1 and subsequently was used to estimate juvenile MNI. Graves 20 and 21, as well as the Parking Lot grave 1 were relatively straight-forward in determining how many juvenile individuals were estimated to be in each grave. Graves 5 and 19 were more complex in determining how many juvenile individuals were present in these graves. The juvenile remains from grave 5 were very few and poorly preserved. In order to have an estimate for grave 5, MNI of the first metatarsal was utilized, which was coupled with the age estimation of smaller bones. Therefore, grave 5 utilized both age estimations and multiple counts of one bone in order to determine the overall MNI of the grave. Similarly, in order to estimate MNI in grave 19 two different bones needed to be combined that would result in an accurate count of how many juveniles were present. Age estimations from long bone measurements of the femora as well as formation stages of the os coxae are what were used to estimate the number of individuals in grave 19.

Results

MNI and MLNI were calculated for adult remains in each of the five graves on the Ismenion Hill. Each of the graves analyzed had fairly small sample sizes, yet differences in the MNI and MLNI estimations were present. Assistance in determining MLNI estimations was provided through the use of an Excel spreadsheet formatted by Adams and Konigsberg (2004, 2008) and can be viewed at http://konig.la.utk.edu/MLNI/html. Adams and Konigsberg (2004, 2008) also discuss the use of an appropriate confidence interval called the "highest density region" (HDR). The confidence interval for each of the MLNI estimations is approximately 95%, and "the lower limit of the interval cannot be less than L + R – P" (Adams and Konigsberg, 2008:252).

As was previously discussed, the estimations for numbers of adult individuals and juvenile individuals will be approached separately in this section. Adult remains will be considered first, followed by the remains of the juvenile individuals. As graves 19 and 20 appear to be similar they will be discussed first, followed by graves 5, 21, and Parking Lot grave 1.

The elements used for estimates of grave 20 were the radius, ulna, humerus, tibia, fibula, and femur. The MNI derived from any of these elements produced an estimation of 6 individuals. To calculate the MLNI for grave 20, any of the previous six skeletal elements could be selected and would provide a point estimation of 6 individuals **(Table 1)**. Grave 20 is an example where the MNI and the MLNI provide estimations that indicate the same number of individuals in the grave.

Grave 19 was similarly composed to grave 20. These two graves are comparable because initial overview suggested that there were complete or nearly complete skeletons and that a large majority of skeletal remains were well-preserved. The elements that were most numerous to provide the MNI estimation were the right talus, the right and left calcaneus, and the left and right fibula. From these inventory counts the MNI is recorded as 8 individuals. Of the seven elements inventoried for this grave, the point estimates for MLNI range from 7 to 9 individuals **(Table 2)**.

However, the MNI and MLNI count may be slightly inflated. In grave 19, for each set of radii, humeri, tibiae, and femora there is also a pair from an adolescent juvenile with an estimated age-of-death of 10 to 14 years (Scheuer and Black, 2000). This would bring the count of pairs to 7 adult pairs and 1 juvenile pair. This is slightly different when observing the fibulae pairs. There are eight pairs of fibulae, yet a juvenile pair is not easily distinguished. On the other hand, one of the fibulae pairs is only shafts that do not have distal or proximal ends present. This pair may in fact be a juvenile pair that is not easily distinguished and subsequently counted as an adult pair. Considering this scenario I would suggest that it could be possible that there are 7 adult individuals in this grave.

While graves 19 and 20 were well-preserved, perhaps as a result of their deposition history, grave 21 had considerably less well-preserved skeletal remains. The bones that make up the axial skeleton and the upper limbs had low inventory totals in the recovered remains and most of the counts came from the tibiae, fibulae, calcanei, and tali. However, the tibia and fibula elements were all severely fragmented and were difficult to pair-match. The MNI of 13 adults was taken from the right calcaneus and the right talus which were the most numerous elements.

The calcaneus and the talus also provided the most numerous left-right pairs and were used to derive the MLNI **(Table 3)**. The MLNI from the calcaneus provided a point estimate of 14, whereas the talus provided a point estimate of 16. The MLNI estimations for this grave are higher than what the MNI estimations have provided which suggests that there is the potential that something has occurred to affect the skeletal preservation and recovery. Since the MLNI estimation is slightly higher than the MNI, this suggests that the MNI reflects an underestimation of the original population deposited in the burial.

Similar results to grave 21 were also found in grave 5. Skeletal elements excavated from this grave are relatively complete and in good condition. However, there are no complete skeletons and a complete inventory showed that crania, vertebrae, ribs, upper and lower arms, os coxae, femora, and hands are largely absent from the recovered remains. The most numerous elements for grave 5 were calcanei, tali, and fibulae. These bones were used for both MNI and MLNI calculations **(Table 4)**. From these elements the MNI is estimated as 9 adult individuals. MLNI was also derived from these three elements and the calcanei, tali, and fibulae provided point estimates of 15, 14, and 9, respectively.

The final grave analyzed was Parking Lot grave 1. This grave was problematic in both sorting and inventorying as well as in calculating MNI and MLNI. The challenge with analyzing this burial came from the recording of a wall being built through the middle of the grave. The majority of bones recorded from the North side of the grave were from the upper skeleton and the majority of the bones recorded from the South side of the grave were lower body elements. This may suggest that the wall was built right through the grave after the remains were buried. The remains were inventoried as North side and South side as recorded during excavation.

The best preserved and most numerous elements from the North side of the grave were the tali, fibulae, and tibiae. The MNI for this section of the grave is best estimated using Max (L,R) of the tibiae which gives an estimate of 10 adult individuals **(Table 5)**. The MLNI point estimates derived from the tibiae and tali result in 8 and 10 individuals, respectively. The MNI from the fibula counts shows 9 individuals which suggest that there are 8 to 10 adult individuals in this grave. The best preserved and most numerous elements from the South side of the grave are the distal third of the diaphysis of the humeri [Max (L,R)=(2,5)] and the talus [Max (L,R)=(2,3)]. The MNI for the South side of the grave is 5 individuals. However; the fragmentation of the humeri and the destruction levels of the tali prevented pair-matching from being accomplished successfully. The counts of bones and the inability to pair-match these elements would not have yielded enough in order to perform MLNI estimations for this section of the grave.

At the present, I have only discussed looking at Parking Lot grave 1 as two separate entities; however, there is the potential to think about this grave as one burial. Consequently, it could be appropriate to combine certain elements to increase population estimations. In this instance, if the tali counts were to be combined then the overall MNI total for the entire grave would be raised to 11 [Max (L,R)=(10,11)]. However, because the tali from the South side of the grave were not preserved enough to be able to make matches on either side of the grave, the MLNI cannot be corrected to account for the South side tali.

**Table 1** Pair-matching results and estimations for grave 20

| Element | Total Lefts | Total Rights | Pairs | MLNI | MNI (Max L,R) |
|---|---|---|---|---|---|
| **Radius, Ulna, Humerus, Tibia, Fibula, Femur** | 6 | 6 | 6 | 6 (6−7) | 6 |

*The numbers in parentheses denotes the approximate 95% confidence interval (HDR).

**Table 2** Pair-matching results and estimations for grave 19

| Elements | Total Lefts | Total Rights | Pairs | MLNI | MNI (Max L,R) |
|---|---|---|---|---|---|
| **Radius, Humerus, Tibia, Femur** | 7 | 7 | 7 | 7 (7−8) | 7 |
| **Fibula** | 8 | 8 | 8 | 8 (8−9) | 8 |
| **Calcaneus** | 8 | 8 | 7 | 9 (9−11) | 8 |
| **Talus** | 6 | 8 | 6 | 8 (8−10) | 8 |

*The numbers in parentheses denotes the approximate 95% confidence interval (HDR).

**Table 3** Pair-matching results and estimations for grave 21

| Element | Total Lefts | Total Rights | Pairs | MLNI | MNI (Max L,R) |
|---|---|---|---|---|---|
| **Calcaneus** | 8 | 13 | 7 | 14 (14−21) | 13 |
| **Talus** | 9 | 13 | 7 | 16 (15−25) | 13 |

*The numbers in parentheses denotes the approximate 95% confidence interval (HDR).

**Table 4** Pair-matching results and estimations for grave 5

| Element | Total Lefts | Total Rights | Pairs | MLNI | MNI (Max L,R) |
|---|---|---|---|---|---|
| **Calcaneus** | 9 | 9 | 5 | 15 (13−30) | 9 |
| **Talus** | 9 | 9 | 6 | 14 (12−21) | 9 |
| **Fibula** | 9 | 8 | 8 | 9 (9−10) | 9 |

*The numbers in parentheses denotes the approximate 95% confidence interval (HDR).

**Table 5** Pair-matching results and estimations for Parking Lot grave 1*

| Element | Total Lefts | Total Rights | Pairs | MLNI | MNI (Max L,R) |
|---|---|---|---|---|---|
| **Tibia (N)** | 10 | 7 | 7 | 10 (10−13) | 10 |
| **Talus (N)** | 8 | 8 | 8 | 8 (8−9) | 8 |
| **Fibula (N)** | 9 | 8 | - | - | 9 |
| **Humerus (S)** | 2 | 5 | - | - | 5 |
| **Talus (S)** | 2 | 3 | - | - | 3 |
| **Talus (Combined)** | 10 | 11 | - | - | 11 |

*The inventory is provided for the North side (N), South side (S), and combined talus counts.
The numbers in parentheses denotes the approximate 95% confidence interval (HDR).

The results of MNI for the juvenile remains from each of these graves required the use of different methods as well as alternate bones that were not used for the adult estimations. As the petrous portion of the temporal is a bone that can withstand destruction and taphonomic pressures (Lewis, 2009; Scheuer and Black, 2000), it was very important in determining MNI for graves 20, 21, and Parking Lot grave 1. For the juveniles in grave 20, the left petrous portion shows 5 individuals as the juvenile MNI. Grave 21 presents a similar estimation using the petrous portion, where based on Max (L,R), the right petrous portion provides an MNI estimation of 7 individuals. The final grave where the petrous portion was able to provide an estimate for the number of juveniles was the Parking Lot grave 1, which the left petrous portion provided the most numerous count of juvenile skeletal elements as 6 juvenile individuals.

Graves 5 and 19 were slightly more complicated in analysis of MNI because these estimations required using ageing techniques for certain remains. Grave 5 had few bones that were numerous in repetition; however, there was recurrence with the first metatarsal. Using the left or right metatarsal, the MNI can initially be documented as two juvenile individuals likely between the ages of 14-16 and 10-12, respectively (Scheuer and Black, 2000). The size and stage of formation for these metatarsals are too large and more developed to accommodate some of the other juvenile bones found within the grave. Keeping this in mind, there were smaller, singular bones that were examined from the grave and this suggests that there was at least one other, much younger individual in grave 5. Age for this younger juvenile was estimated using the humerus, radius, pars basilaris, and pars lateralis. Each of these bones provided an estimation of approximately 40 weeks (Schaefer et al., 2009; Scheuer and Black, 2000). This brings the total of juvenile remains to 3.

The MNI for juveniles in grave 19 was estimated using a combination of os coxae **(Figure 1)** and femora **(Figure 2)**. Initial counts of these two sets of elements would provide an MNI of 4 individuals based on four left os coxae and four right femora. However, this is where age estimations can help differentiating juvenile remains. The sizes and states of fusion for the os coxae and the femora conflict with one another. For the os coxae there are two larger innominates likely from older juveniles, one from a smaller individual, and another one from an even smaller individual. On the other hand, the femora show one larger femur of an older juvenile before epiphyses have fused, and three much smaller femora. Therefore, a case can be made for an extra young juvenile, which would bring the MNI for grave 19 to 5 juveniles **(Table 6)**.

**Figure 1**. Left juvenile os coxae from grave 19. From left to right (os coxa A-D). Photo by author.

**Figure 2**. Juvenile femora from grave 19. From left to right (femur A-D). Photo by author.

**Table 6** Juvenile ages for grave 19 estimated from os coxae and femora

| Element | Side | Age-at-Death |
|---|---|---|
| Os Coxa A | Left | 10 to 14 years |
| Os Coxa B | Left | 17 to 20 years |
| Os Coxa C | Left | Birth to 1 year |
| Os Coxa D | Left | 36 to 38 weeks |
| Femur A | Left | 10 to 12 years |
| Femur B | Right | 0.5 to 1 year |
| Femur C | Right | 37 weeks |
| Femur D | Right | 29 weeks |

(Scheuer and Black, 2000).

## Discussion

The results of the MNI and MLNI estimations for the five burials studied in Thebes, Greece have provided a discussion for how these estimations can help decode burial context and funerary practices at this site. The estimations from each method and each grave have the ability to tell us something about what type of burial is present. The equal estimation from grave 20 of 6 adult individuals using both MNI and MLNI suggest that there were high levels of preservation and little disturbance and that the recovery of the grave contents was complete. Grave 19 yielded MNI and MLNI estimates that were very similar suggesting that this grave also had high levels of preservation, little disturbance, and recovery. The MNI and MLNI results for graves 5, 21, and Parking Lot grave 1 provided differing estimations which suggests that factors have influenced the recovery rate of the grave contents prior to excavation.

What do these population estimation numbers mean for the types of burials that have been excavated in Thebes? I am suggesting that the graves with similar MNI and MLNI estimations that record an inventory of an almost complete skeleton represent a burial practice that is representative of a single event (Adams and Konigsberg, 2008). This means that individuals buried were interred in a synchronous approach and likely not disturbed once the grave was finally closed (Roksandic, 2002). I believe this to be the categorization for graves 19 and 20. The three graves that have differing or conflicting MNI and MLNI estimations have had some factor affecting the preservation or recovery rate such as taphonomy, post-depositional disturbances, or cultural intervention (Atici, 2014; Boz and Hager, 2014; Fox and Marklein, 2014; Ubelaker, 2002; Ubelaker and Rife, 2008).

For graves 5 and 21 there appear to be some events that have affected the preservation or presence of certain bones and therefore affected what could be excavated from the grave. There is a bias towards the recovery of bones from the lower leg and foot indicating that there has been preferential removal of bones from the upper body. This means that a bias was created due to the ritual exhumation and removal of selected elements and the cultural reuse of the same burial. The removal of bones to ossuaries or secondary locations is a funerary practice that has been documented throughout Greek culture and is likely to have occurred with these two graves (Danforth, 1982; Fox and Marklein, 2014; Symeonoglou, 1985). Graves 5 and 21 likely have a similar depositional history where they were subjected to repeated events of opening the grave, removing some elements, mostly from the upper body, and then reusing the burial for another individual.

This explanation can be supported by analysis of the grave inventory. Both graves 5 and 21 demonstrate a contrast between the number of upper body bones preserved compared to the lower body bones. In both these burials there are less skeletal elements recovered from the cranial and upper post-cranial skeleton than from the lower post-cranial skeleton. For example, grave 5 had almost no arm bones recovered from this grave. Grave 21 had fewer upper limb elements when compared to the lower limbs. The contrast in the preservation of upper body elements to lower body elements certainly appears to reflect a cultural practice in which upper body elements were preferentially removed (Danforth, 1982). This also influenced why lower leg bones and tarsals were selected for MNI and MLNI estimations.

Parking Lot grave 1 appeared to be a special and complex case. While it did have samples of skeletal elements from all parts of the skeleton, the destruction and level of preservation of the grave has affected the reliability of the MNI and MLNI estimations. For the tibia in this grave, both the MNI (10) and MLNI (10) are equal. This is also the case for the MNI (8) and MLNI (8) of the talus. The population estimates for this burial differ between elements but within each element the MNI and MLNI are consistent. However, while the MNI and MLNI estimations are similar, I would not equate this burial with the other graves that had similar MNI and MLNI estimations and little disturbance.

The level of fragmentation, destruction, and commingling as well as the recording of a wall being constructed through the burial suggests that there were disturbances that affected the interred individuals after they had already been buried. The people may have all been buried at the same time but the post-depositional disturbances that affected the grave show this may be an instance where using MLNI may not offer a more accurate estimate over MNI. This shows that the events and disturbances that occur after remains have been deposited can consequently add complexity to analysis and the conclusions that can be drawn (Baustian et al., 2014). In this case, it would likely be more valuable to focus on the types of bones removed from the grave and the completeness of elements as indicators of burial type. It may be that this grave needs to be examined further to understand exactly how it is different from the other graves at Ismenion Hill, especially when taking into consideration that it was not discovered on the hill at the site.

Each of the MLNI estimations also provided a range of values for the "highest density region" (HDR). The graves that had the similar MNI and MLNI estimations, such as graves 19 and 20, had an HDR value range that was relatively small **(see Tables 1 and 2)**. For the graves that showed differences between MNI and MLNI estimations, with a higher value for MLNI, demonstrated an HDR value range that was considerably larger **(see Tables 3 and 4)**. Parking Lot grave 1 had a relatively smaller range of HDR values **(Table 5)** which supports the interpretation that this burial may have occurred synchronously; however, the low numbers of pairs and visible destruction of bones also suggests that this grave had high levels of disturbance.

The initial interpretations of the burials considered by the site directors were supported by the results of the MNI and MLNI estimations. The graves that provided the same or very similar estimations support the interpretation that individuals were likely interred as a mass event with little disturbance after the grave was sealed. The graves where the MNI and MLNI estimates were different provide evidence that once the individuals were buried there was interference, such as selected removal of elements, which affected the remains. Therefore, the similarities and differences between the MNI and MLNI estimations can be used as an additional technique to help distinguish between single event mass graves and reused burials for multiple individuals. The results from each of these graves also demonstrated that MLNI provided higher population estimates than if MNI was the sole quantification method. This suggests that even with small amounts of commingled remains, MLNI can provide better estimations for the original number of individuals deposited in the grave (Adam and Konigsberg, 2004; 2008).

Juvenile remains were also present in all five of the graves that were analyzed. However, one challenge when working with the juvenile remains is the difficulty in pair-matching the bones. In many instances, juvenile bones can be difficult to find well-preserved and can often be missed in the archaeological record (Lewis, 2009). In this instance, there were not enough bones available in order to pair-match for MLNI estimations for the juveniles. For situations such as this, understanding the MNI for juveniles was based mostly upon age-at-death estimations, as segregating individuals through age was more successful than pair-matching. It would be interesting to look further into the accuracy of pair-matching juvenile elements and which bones may work best in order to calculate MLNI estimations for burials with many juvenile remains.

Unlike many cultures where juveniles can be found in different areas than adults (Lewis, 2009), it appears in Thebes that the juveniles were buried in the same locations as the adults. The juveniles that were excavated from these graves show a range of age from perinatal to adolescent. There was also presence of skeletal elements from all areas of the skeleton and no visible patterned removal of certain bones. This could suggest that the juveniles may not have had the same secondary burial treatment as adults. An area to investigate specific to juvenile remains would be whether or not the bones of juveniles are removed to secondary locations such as ossuaries and if exhumation happens at the same rates as adult remains.

## Conclusion

The goal of this research was to attempt to identify an additional technique for distinguishing different types of burials as it pertains to Ismenion Hill in Thebes, Greece. I also wanted to discuss the accuracy and applicability of using MNI and MLNI as estimation techniques for burials and what the similarities or differences between those estimation numbers can tell us about specific burials. The types of burials that I wanted to see if we could understand were burials that are primary inhumations from a single event compared to burials that may have occurred over an extended period of time and most likely have had skeletal elements removed to ossuaries (Adams and Konigsberg, 2004, 2008; Baustian et al., 2014; Fox and Marklein, 2014; Roksandic, 2002; Weiss-Krejci, 2011).

Generally, the estimations provided from MNI and MLNI supported differentiation between two burial types in Thebes, Greece. Graves 19 and 20 had very similar MNI and MLNI and high numbers of pairs. These results support the interpretation that these were both single event mass graves with minimal disturbance and commingling. The estimation results for graves 5 and 21 were different with low numbers of pairs being recorded and MLNI estimations that were higher than MNI estimations. Results from these graves support the idea that these were burials used from the ritual inhumation and exhumation of multiple individuals. The conflicting results from Parking Lot grave 1 demonstrate how extreme disturbances can impact the ease of categorizing burials based exclusively on the differences in MNI and MLNI.

I would caution against using these estimations as sole distinguishers of grave types and should be used in conjunction with other methods used to understand mortuary archaeology; however, the use of MNI and MLNI helped to confirm interpretations made during early stages of excavation and analysis. Testing these two estimation methods allowed me to answer the specific questions raised by the site archaeologists about the five selected graves from Ismenion Hill. Both MNI and MLNI were applicable in this study and the results were able to demonstrate a difference between burials and provide additional information about the burials at the site in Thebes.

Valuable areas to consider for future research would be to closely examine juvenile remains and continue to modify the methods for estimating juveniles. Since only MNI was observed in the juveniles, improvement into pair-matching juvenile remains for MLNI may increase estimates of juvenile individuals. Pair-matching smaller and more challenging bones could also be an aspect to improve this study. Hand and foot bones are often not transported to ossuaries, so their numbers may be able to offer an accurate estimation of grave population on condition that these bones can be accurately differentiated into sides and pairs. As this research was focused on the quantification methods of MNI and MLNI, there was less attention focused on biological information of the individual skeletons. Factors such as age, sex, and pathology were not evaluated closely which could potentially provide more data on context and information about the specific burials.

Lastly, it would be interesting to consider if these questions and methods could be applied to other archaeological sites. In this study, differentiation between burial types was able to be distinguished. A future direction would be the applicability of this research to different archaeological sites. An important outcome would be whether or not these two quantification methods can provide reasonable distinction between burials found at different sites. It would be important to consider regions that have different cultural practices and levels of disturbance to determine if these methods were only successful for the archaeological site in Thebes or if they can be applied to a variety funerary practices.

References

Adams BJ, Byrd JE. 2006. Resolution of small-scale commingling: A case report from the Vietnam War. *Forensic Science International* 156(1): 63-69.

Adams BJ, Konigsberg LW. 2004. Estimations of the most likely number of individuals from commingled human skeletal remains. *American Journal of Physical Anthropology* 125(2): 138-151.

Adams BJ, Konigsberg LW. 2008. How Many People? Determining the Number of Individuals Represented by Commingled Human Remains. In *Recovery, Analysis, and Identification of Commingled Human Remains*, Adams BJ, Byrd, JE (eds.). Humana Press, New Jersey; 241-255.

Atici L. 2014 Commingled Bone Assemblages: Insights from Zooarchaeology and Taphonomy of a Bone Bed at Karain B Cave, SW Turkey. In *Commingled and Disarticulated Human Remains: Working Toward Improved Theory, Method, and Data*, Osterholtz AJ, Baustian KM, Martin DL (eds.). Springer; New York; 213-253.

Baustian KM, Osterholtz AJ, Cook DC. 2014. Taking Analyses of Commingled Remains into the Future: Challenges and Prospects. In *Commingled and Disarticulated Human Remains: Working Toward Improved Theory, Method, and Data*, Osterholtz AJ, Baustian KM, Martin DL (eds.). Springer; New York; 265-274.

Boz B, Hager LD. 2014. Making Sense of Social Behavior from Disturbed and Commingled Skeletons: A Case Study from Çatalhöyük, Turkey. In *Commingled and Disarticulated Human Remains: Working Toward Improved Theory, Method, and Data*, Osterholtz AJ, Baustian KM, Martin DL (eds.). Springer; New York; 17-33.

Daly K, Larson S, Charami A, Kalamara P, Aravantinos V. 2013. Excavation in Thebes, Boeotia, Greece: Results of Work on and near the Ismenion Hill, 2011-2012 [Abstract]. *Archaeological Institute of America 114$^{th}$ Annual Meeting Abstracts* 36: 149-150.

Danforth LM. 1982. *The Death Rituals of Rural Greece*. Princeton University Press: New Jersey.

Fox SC, Marklein K. 2014. Primary and Secondary Burials with Commingled Remains from Archaeological Contexts in Cyprus, Greece, and Turkey. In *Commingled and Disarticulated Human Remains: Working Toward Improved Theory, Method, and Data*, Osterholtz AJ, Baustian KM, Martin DL (eds.). Springer; New York; 173-192.

Garrido Varas C, Intriago Leiva M. 2012. Managing commingled remains from mass graves: Considerations, implications and recommendations from a human rights case in Chile. *Forensic Science International*. 219: e19-e24.

Glencross B. 2014. Into the Kettle: The Analysis of Commingled Remains from Southern Ontario. In *Commingled and Disarticulated Human Remains: Working Toward Improved*

*Theory, Method, and Data*, Osterholtz AJ, Baustian KM, Martin DL (eds.). Springer; New York; 67-82.

Hadjimatheou, C. 2015. Why Greeks are exhuming their parents. *BBC News*, November 26, 2015. Accessed November 26, 2015. http://www.bbc.com/news/magazine-34920068.

Herrmann NP, Devlin JB, Stanton JC. 2014. Assessment of Commingled Remains Using GIS-Based and Osteological Landmark Approach. In *Commingled Human Remains: Methods in Recovery, Analysis, and Identification*, Adams BJ, Byrd, JE (eds.). Academic Press, San Diego, CA; 221-237.

Jessee E, Skinner M. 2005. A typology of mass grave and mass grave-related sites. *Forensic Science International* 152(1): 55-59.

Kendall A, Willey P. 2014. Crow Creek Bone Bed Commingling: Relationship Between Bone Mineral Density and Minimum Number of Individuals and Its Effect on Paleodemographic Analysis. In *Commingled and Disarticulated Human Remains: Working Toward Improved Theory, Method, and Data*, Osterholtz AJ, Baustian KM, Martin DL (eds.). Springer; New York; 85-104.

Konigsberg LW, Adams BJ. 2014. Estimating the Number of Individuals Represented by Commingled Human Remains: A Critical Evaluation of Methods. In *Commingled Human Remains: Methods in Recovery, Analysis, and Identification*, Adams BJ, Byrd, JE (eds.). Academic Press, San Diego, CA; 193-220.

L'Abbé EN. 2005. A case of commingled remains from rural South Africa. *Forensic Science International* 151(2-3): 201-206.

Lewis ME. 2009. *The Bioarchaeology of Children: Perspectives from Biological and Forensic Anthropology.* Cambridge University Press: New York.

Osterholtz AJ, Baustian KM, Martin DL, Potts DT. 2014. Commingled Human Skeletal Assemblages: Integrative Techniques in Determination of the MNI/MNE. In *Commingled and Disarticulated Human Remains: Working Toward Improved Theory, Method, and Data*, Osterholtz AJ, Baustian KM, Martin DL (eds.). Springer; New York; 35-50.

R Core Team. 2015. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Roksandic M. 2002. Position of Skeletal Remains as a Key to Understanding Mortuary Behavior. In *Advances in Forensic Taphonomy: Method, Theory, and Archaeological Perspectives*, Haglund WD, Sorg MH, (eds.). CRC Press: Florida; 99-115.

Schaefer M, Black S, Scheuer L. 2009. *Juvenile Osteology*. Academic Press: San Diego, CA.

Scheuer L, Black S. 2000. *Developmental Juvenile Osteology.* Academic Press: San Diego, CA.

Sorg, MH, Haglund WD. 2002. Advancing Forensic Taphonomy: Purpose, Theory, and Practice. In *Advances in Forensic Taphonomy: Method, Theory, and Archaeological Perspectives*, Haglund WD, Sorg MH, (eds.). CRC Press: Florida; 3-30.

Symenonoglou S. 1985. *The Topography of Thebes: From the Bronze Age to Modern Times.* Princeton University Press: New Jersey.

Ubelaker DH. 2002. Approaches to the Study of Commingling in Human Skeletal Biology. In *Advances in Forensic Taphonomy: Method, Theory, and Archaeological Perspectives*, Haglund WD, Sorg MH, (eds.). CRC Press: Florida; 331-351.

Ubelaker DH, Rife JL. 2008. Approaches to Commingling Issues in Archaeological Samples: A Case Study from Roman Era Tombs in Greece. In *Recovery, Analysis, and Identification of Commingled Human Remains,* Adams BJ, Byrd, JE (eds.). Humana Press, New Jersey; 97-122.

Weiss-Krejci E. 2011. The Formation of Mortuary Deposits: Implications for Understanding Mortuary Behavior of Past Populations. In *Social Bioarchaeology,* Agarwal SC, Glencross BA (eds.). Blackwell-Wiley: Malden, MA; 68-106.

Wheeler, B. 2013. SuppDists: Supplementary distributions. R package version 1.1-9.1. http://CRAN.R-project.org/package=SuppDists.

Appendix

Listed below are the Inventory Recording Forms for graves 5, 19, 20, 21, and Parking Lot grave 1.

**Inventory Recording Form**

| | |
|---|---|
| **Grave Number** | **5** |
| **Date** | **June 23/2015** |

| **Bone Type** | **Whole** | **Proximal End/Epiphysis** | **Proximal 1/3 Diaphysis** | **Middle 1/3 Diaphysis** | **Distal 1/3 Diaphysis** | **Distal End/Epiphysis** |
|---|---|---|---|---|---|---|
| L. Humerus | 0 | 0 | 0 | 0 | 0 | 0 |
| R. Humerus | 0 | 0 | 0 | 0 | 0 | 0 |
| L. Radius | 0 | 0 | 0 | 0 | 0 | 0 |
| R. Radius | 0 | 0 | 0 | 0 | 0 | 0 |
| L. Ulna | 0 | 0 | 0 | 0 | 0 | 0 |
| R. Ulna | 0 | 0 | 0 | 0 | 0 | 0 |
| L. Femur | 0 | 0 | 0 | 2 | 3 | 3 |
| R. Femur | 0 | 0 | 0 | 2 | 5 | 4 |
| L. Tibia | 1 | 4 | 5 | 8 | 9 | 9 |
| R. Tibia | 1 | 2 | 3 | 6 | 5 | 6 |
| L. Fibula | 2 | 3 | 7 | 9 | 9 | 9 |
| R. Fibula | 1 | 5 | 5 | 6 | 5 | 8 |
| L. Clavicle | 0 | | | | | |
| R. Clavicle | 0 | | | | | |
| L. Calcaneus | 9 | | | | | |
| R. Calcaneus | 9 | | | | | |
| L. Talus | 9 | | | | | |
| R. Talus | 9 | | | | | |

**Inventory Recording Form**

**Grave Number** **19**

**Date** **June 29/2015**

| **Bone Type** | **Whole** | **Proximal End/Epiphysis** | **Proximal 1/3 Diaphysis** | **Middle 1/3 Diaphysis** | **Distal 1/3 Diaphysis** | **Distal End/Epiphysis** |
|---|---|---|---|---|---|---|
| L. Humerus | 4 | 4 | 6 | 6 | 7 | 8 |
| R. Humerus | 5 | 6 | 7 | 8 | 8 | 7 |
| L. Radius | 5 | 7 | 7 | 8 | 6 | 6 |
| R. Radius | 5 | 8 | 8 | 8 | 6 | 6 |
| L. Ulna | 4 | 8 | 8 | 5 | 4 | 5 |
| R. Ulna | 4 | 8 | 7 | 7 | 5 | 5 |
| L. Femur | 2 | 2 | 7 | 8 | 8 | 8 |
| R. Femur | 7 | 7 | 8 | 8 | 5 | 7 |
| L. Tibia | 5 | 5 | 8 | 8 | 8 | 8 |
| R. Tibia | 4 | 5 | 8 | 8 | 8 | 8 |
| L. Fibula | 2 | 4 | 7 | 8 | 8 | 7 |
| R. Fibula | 3 | 5 | 8 | 8 | 8 | 6 |
| L. Clavicle | 4 | Sternal end - 4 | Medial half - 4 | | Lateral half - 6 | Lateral end - 6 |
| R. Clavicle | 5 | Sternal end - 7 | Medial half - 6 | | Lateral half - 6 | Lateral end - 7 |
| L. Calcaneus | 8 | | | | | |
| R. Calcaneus | 8 | | | | | |
| L. Talus | 6 | | | | | |
| R. Talus | 8 | | | | | |

**Inventory Recording Form**

| | |
|---|---|
| **Grave Number** | **20** |
| **Date** | **June 16/2015** |

| **Bone Type** | **Whole** | **Proximal End/Epiphysis** | **Proximal 1/3 Diaphysis** | **Middle 1/3 Diaphysis** | **Distal 1/3 Diaphysis** | **Distal End/Epiphysis** |
|---|---|---|---|---|---|---|
| L. Humerus | 3 | 5 | 3 | 6 | 6 | 6 |
| R. Humerus | 3 | 5 | 6 | 5 | 5 | 5 |
| L. Radius | 6 | 6 | 6 | 6 | 6 | 5 |
| R. Radius | 6 | 6 | 6 | 6 | 6 | 6 |
| L. Ulna | 4 | 6 | 6 | 6 | 6 | 4 |
| R. Ulna | 4 | 6 | 6 | 6 | 6 | 4 |
| L. Femur | 1 | 2 | 6 | 6 | 6 | 6 |
| R. Femur | 2 | 2 | 6 | 6 | 6 | 6 |
| L. Tibia | 5 | 5 | 6 | 6 | 6 | 6 |
| R. Tibia | 3 | 6 | 6 | 6 | 5 | 5 |
| L. Fibula | 3 | 5 | 6 | 6 | 6 | 5 |
| R. Fibula | 3 | 4 | 4 | 5 | 6 | 4 |
| L. Clavicle | 5 | Sternal end - 6 | Medial half - 4 | | Lateral half - 5 | Lateral end - 5 |
| R. Clavicle | 4 | Sternal end - 6 | Medial half - 5 | | Lateral half - 6 | Lateral end - 4 |
| L. Calcaneus | 6 | | | | | |
| R. Calcaneus | 5 | | | | | |
| L. Talus | 6 | | | | | |
| R. Talus | 5 | | | | | |

**Inventory Recording Form**

**Grave Number** **21**

**Date** **June 19/2015**

| **Bone Type** | **Whole** | **Proximal End/Epiphysis** | **Proximal 1/3 Diaphysis** | **Middle 1/3 Diaphysis** | **Distal 1/3 Diaphysis** | **Distal End/Epiphysis** |
|---|---|---|---|---|---|---|
| L. Humerus | 0 | 0 | 0 | 2 | 3 | 3 |
| R. Humerus | 0 | 1 | 1 | 2 | 2 | 1 |
| L. Radius | 1 | 1 | 3 | 3 | 2 | 3 |
| R. Radius | 1 | 3 | 3 | 3 | 2 | 2 |
| L. Ulna | 0 | 2 | 3 | 1 | 1 | 2 |
| R. Ulna | 0 | 1 | 2 | 2 | 1 | 1 |
| L. Femur | 1 | 5 | 6 | 8 | 6 | 5 |
| R. Femur | 2 | 2 | 7 | 8 | 8 | 9 |
| L. Tibia | 1 | 5 | 9 | 10 | 8 | 8 |
| R. Tibia | 2 | 5 | 9 | 11 | 11 | 8 |
| L. Fibula | 4 | 6 | 5 | 7 | 8 | 8 |
| R. Fibula | 6 | 9 | 12 | 11 | 12 | 11 |
| L. Clavicle | 0 | | | | | |
| R. Clavicle | 0 | | | | | |
| L. Calcaneus | 8 | | | | | |
| R. Calcaneus | 13 | | | | | |
| L. Talus | 9 | | | | | |
| R. Talus | 13 | | | | | |

**Inventory Recording Form**

| | | |
|---|---|---|
| **Grave Number** | **Parking Lot Grave 1** | |
| **Date** | **July 7/2015** | NORTH SIDE |

| **Bone Type** | **Whole** | **Proximal End/Epiphysis** | **Proximal 1/3 Diaphysis** | **Middle 1/3 Diaphysis** | **Distal 1/3 Diaphysis** | **Distal End/Epiphysis** |
|---|---|---|---|---|---|---|
| L. Humerus | 0 | 0 | 1 | 1 | 1 | 2 |
| R. Humerus | 0 | 0 | 1 | 1 | 1 | 0 |
| L. Radius | 1 | 1 | 1 | 1 | 1 | 1 |
| R. Radius | 0 | 0 | 0 | 0 | 0 | 0 |
| L. Ulna | 1 | 2 | 2 | 1 | 1 | 1 |
| R. Ulna | 0 | 0 | 0 | 0 | 0 | 0 |
| L. Femur | 1 | 1 | 1 | 3 | 3 | 3 |
| R. Femur | 1 | 1 | 2 | 3 | 4 | 4 |
| L. Tibia | 2 | 2 | 7 | 8 | 10 | 7 |
| R. Tibia | 2 | 2 | 5 | 7 | 7 | 3 |
| L. Fibula | 0 | 0 | 7 | 9 | 7 | 4 |
| R. Fibula | 0 | 1 | 8 | 7 | 8 | 5 |
| L. Clavicle | 0 | | | | | |
| R. Clavicle | 0 | | | | | |
| L. Calcaneus | 9 | | | | | |
| R. Calcaneus | 7 | | | | | |
| L. Talus | 8 | | | | | |
| R. Talus | 8 | | | | | |

SOUTH SIDE

| **Bone Type** | **Whole** | **Proximal End/Epiphysis** | **Proximal 1/3 Diaphysis** | **Middle 1/3 Diaphysis** | **Distal 1/3 Diaphysis** | **Distal End/Epiphysis** |
|---|---|---|---|---|---|---|
| L. Humerus | 0 | 0 | 0 | 2 | 2 | 1 |
| R. Humerus | 0 | 0 | 1 | 2 | 5 | 2 |
| L. Radius | 0 | 0 | 0 | 0 | 0 | 1 |
| R. Radius | 0 | 0 | 1 | 1 | 1 | 2 |
| L. Ulna | 0 | 0 | 0 | 0 | 1 | 2 |
| R. Ulna | 0 | 3 | 1 | 0 | 1 | 1 |
| L. Femur | 0 | 0 | 0 | 2 | 0 | 0 |
| R. Femur | 0 | 1 | 1 | 2 | 2 | 1 |
| L. Tibia | 0 | 1 | 0 | 0 | 0 | 0 |
| R. Tibia | 0 | 0 | 1 | 1 | 1 | 0 |
| L. Fibula | 0 | 0 | 0 | 0 | 0 | 2 |
| R. Fibula | 0 | 0 | 0 | 0 | 0 | 1 |

| | |
|---|---|
| L. Clavicle | 3 |
| R. Clavicle | 2 |
| L. Calcaneus | 1 |
| R. Calcaneus | 1 |
| L. Talus | 2 |
| R. Talus | 3 |